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SOME BIOLOGICAL OBSERVATIONS ON *HOPLITIS PILOSIFRONS* and *STELIS LATERALIS* (HYMENOPTERA, MEGACHILIDAE)[1]

By Charles D. Michener

Although the observations here described concern only fragments of the life histories of the bees concerned, they seem worth recording as part of a study of comparative behavior of bees. The observations were made southeast of Lawrence, Kansas, in 1951 except as otherwise indicated.

Excavation of Nest. Females of *Hoplitis* (*Alcidamea*) *pilosifrons* (Cresson) were seen collecting pollen from flowers of *Amorpha fruticosa* on June 1, and a nest was found in a nearly upright dead broken stem of *Helianthus tuberosus*. The female *Hoplitis* was excavating pith from the stalk. She would enter her burrow at the break in the stem, remain inside from one half to two minutes, then back out, carrying bits of pith in her jaws, fly away, and drop the pith. These flights seemed random in direction, took 8 to 20 seconds, and the pith was dropped from one to three feet from the nest. This activity continued for the two hours that the nest was under observation.

Provisioning. On June 4 provisioning activities were observed. Pollen of yellow sweet clover (*Melilotus officinalis*) was being used. On returning from a foraging trip (durations of 4 such trips, 6 to 18 minutes), the bee flew rather directly to the nest, entered head first, presumably disgorged nectar, after 50 to 65 seconds backed out with pollen still on scopa, turned around, backed into nest and after one to five minutes came out head first and flew away. This behavior is surprisingly similar to the provisioning behavior of *Megachile brevis* Cresson (See Michener, 1953) except that the *Hoplitis* burrow is so narrow that the bee apparently cannot turn around inside and must come to the entrance to do so. The number of pollen collecting trips necessary to provision a cell was not determined.

Egg Laying. The egg laying behavior, too, is strikingly like that of *Megachile brevis*. On returning from the last foraging trip for a cell, the bee went through the usual process for disgorging nectar and removing pollen from the scopa, as described in the preceding paragraph, but on coming to the nest entrance after removing pollen, she backed down into the burrow again and was out of sight for two minutes. The egg must have been laid during this period, for on coming out of the nest the bee immediately flew to a leaf and gathered leaf material for a partition between cells.

Construction of Partitions. The partitions between the cells of the nest are made largely of finely divided leaf tissue, although the thicker partitions have particles of pith in the middle between an upper and a lower layer of leaf material. The bee under observation obtained all leaf material from soft and rather young leaves of three *Oenothera* plants growing three to four feet

[1] Contribution number 886 from the Department of Entomology, University of Kansas, Lawrence.

from the nest. These *Oenothera* leaves were soft and quite pubescent, as were the strawberry leaves similarly used by the *Hoplitis producta* (Cresson) described by Graenicher (1905) and Rau (1928). A number of observations of activity during partition construction were made, but one series of observations concerning the construction of one complete partition will exemplify the process. First, seven trips to gather leaf material were made. The duration of the trips ranged from 45 seconds to 2 minutes (average 1.4 minutes); that of the periods between trips ranged from 1 to 3 minutes (average 1.8 minutes). The bee entered the nest head first carrying the leaf material and backed out afterwards.

Following the seventh leaf gathering trip there was a delay of 8 minutes, after which the bee started carrying pith from the nest. Presumably this was pith removed from the walls of the cell being constructed. Pith was brought out of the nest eleven times. Once it was merely kicked from the nest entrance but the other times it was carried off and dropped as was described under Excavation of Nest. These flights took 6 to 10 seconds; intervals between them ranged from 45 seconds to 5 minutes (average 1.6 minutes). In the midst of this activity the bee made occasional trips away from the nest, possibly for nectar. One such trip lasted 17 minutes, another 5 minutes.

After this activity with pith the bee made three flights, about a minute apart, to the vicinity of the *Oenothera* plants but did not alight on them; then it started gathering leaf material with the same tempo as described above for this process. Eight such leaf collecting trips were made before the bee backed out and flew off to return later with pollen. In all, the construction of the partition required about one hour and 40 minutes.

The preceding paragraph provides support for the conclusion reached in a study of *Megachile brevis* Cresson (Michener, 1953) to the effect that minor changes in activity between work with pith and with leaf material in cell construction are often accomplished through intermediate stages while major changes (e.g. the change from pollen collecting to cell construction or vice versa) require no intermediate steps but the change in behavior occurs almost instantaneously.

CUTTING LEAF FRAGMENTS. The bee was repeatedly observed to alight on the edge of an *Oenothera* leaf and immediately start cutting with its mandibles. She was not observed to spend any appreciable time selecting a suitable leaf. Cutting was slow compared with that of *Megachile*. As a piece was cut it was held pressed against the under side of the head by the fore legs, the bee supporting herself by the middle and hind legs. As cutting continued, she curled her body. When a piece was free, she flew to the nest. The pieces cut varied in size and shape (see fig. 2), 1 to 3 mm. in longest dimension. It could not be seen whether the leaf fragments were carried whole or chewed to a pulp, but the former seems more likely. They are chewed before being built into partitions.

NEST STRUCTURE. On June 19, 19 days after construction was first observed, the nest was found sealed with chewed leaf material. It probably was sealed a day or two before. The structure is illustrated in the drawing (fig. 1). The nine cells were 3 mm. in diameter, 8 to 10 mm. long (average 9 mm.).

The partitions range from 1.2 to 5 mm. in thickness (average 2.5 mm.). Another nest in a similar stem contained six similar cells.

The chewed leaf material in the partitions and the thick closing plug all seemed to be from the same kind of plant. The bits of leaves were irregular in shape, mostly about 1 mm. in greatest diameter. Pith fragments (sometimes intermixed with leaf fragments) in the central zone of the thicker partitions were mostly 0.75 to 1.0 mm. long, 0.5 mm. thick. The pith fragments were loose, for which reason it seems likely that the leaf fragments stick together and form firm, hard plugs because of the adhesion of their own dried juices, not because of any substance added by the bee. The upper surfaces of the partitions were smoothly concave, the lower surfaces somewhat irregular but essentially flat.

BEHAVIOR OF *Stelis*. A female of *Stelis lateralis* Cresson was repeatedly observed around the *Hoplitis* nest. The *Stelis* was not marked but it seems likely that it was the same individual present each time. It would appear and alight on leaves or stems near the nest, remain quietly for a short time, then fly to the nest entrance. Twice it was seen to come during partition construction. It merely touched the nest entrance, then flew away. On June 15 at 3:00 p.m. the *Stelis* appeared while the *Hoplitis* was away gathering pollen. The *Stelis* flew to the nest entrance, then quickly away to a stem, then returned and entered the nest head first, came out head first a minute later after presumably laying an egg, and flew away. Three minutes later the *Hoplitis* returned with pollen. The *Stelis* was enough smaller than its host that it could turn around inside the nest. This is not true of all *Stelis*, however, for Höppner (1898) mentions that *Stelis minima* Schenck backs out of its host's nest and then reenters hind end first to lay its egg.

That the *Stelis* did an effective job of parasitization is shown by the fact that a *Stelis* egg was laid in each of the nine cells, two of them in the uppermost cell.

LARVAL BEHAVIOR OF *Stelis*. Each cell was provided with one *Hoplitis* egg (white, slightly curved, 2.75 mm. long) laid horizontally on the top of the pollen mass, which is rather firm in consistency. The *Stelis* eggs (2 mm. long) were found concealed in the pollen mass near the lower end of each cell. The relative time of hatching of the two is unknown but the egg stage of the *Hoplitis* is at least four and probably five or six days in duration.

After hatching, the *Hoplitis* larva at first lies flat on the pollen mass, later feeding downward at one side of the provisions and starting to become curved, just as do young larvae of *Megachile*. In this nest they were all killed by *Stelis* larvae when from 4 to 4.5 mm. long. The structure of the head and mouthparts of the young *Hoplitis* is very similar to that illustrated for mature *H. (Alcidamea)* by Michener (1953a).

The *Stelis* larva in its first stadium is straight, robust, with a ridge on each side of the body, and without dorsal tubercles. The head and mandibles are not enlarged as they are in the first stage larvae of such other parasitic bees as *Coelioxys, Triepeolus,* and *Melecta*. The structure of the head and mouthparts of the young *Stelis* larva is not much different from that of the mature larva of the same species figured by Michener (1953a) except for relatively longer antennae, hairs, etc. The mandibles are acutely pointed in the *Stelis*

throughout larval life, no doubt as an adaptation to parasitic behavior, although this is not a universal feature of *Stelis* larvae. The young *Stelis* larva feeds in a generally upward direction through the pollen mass for about 4 days after hatching. At this time the *Hoplitis* has grown to about 4 mm. in length and the *Stelis* to about 2.75 mm. The *Stelis,* at what is probably its first molt, now changes to a form similar to but more slender than that characteristic of it during the remainder of the larval life, that is, slender, curved, with a series of dorsal tubercles, and without lateral ridges. A mature larva, differing principally by being more robust, is illustrated by Michener (1953a). Because of its more slender body, this stage is nearly 4 mm. long; much more slender and often a little shorter than the host. It works its way to the surface of the food mass and although its mandibles are not enlarged it attacks and kills the *Hoplitis* larva. [Verhoeff (1892) describes an encounter which he observed between the larva of *Stelis minuta* Nylander and its host, *Hoplitis leucomelaena* (Kirby). The *Stelis,* in that case much larger than the host, approached the head of the host; both worked their jaws briefly but the *Stelis* soon crushed the head of its host. After briefly feeding on the head region the *Stelis* concentrated its attention on the midsection of the host's body upon which it fed for a day or two.] Two different *Stelis lateralis* larvae were observed with the head inside a hole in the body of the host. They may eat some of the host tissue. Yet they do not consume the entire host, for in all nine cells the remains of the *Hoplitis* larva lay on the surface of the pollen mass as the *Stelis* continued its development. In some cases the *Stelis* almost certainly eats none of the host, for one *Stelis* larva was seen still occasionally biting at a *Hoplitis* after the latter had been reduced to a soft mass with a crushed head, but with the body itegument apparently still intact. This *Stelis* larva later continued its pollen feeding without eating the dead host larva. In general the above observations agree well with those of Graenicher (1905) based on *S. lateralis* (misidentified as *sexmaculatus* Ashmead) as a parasite of *Hoplitis producta* (Cresson). Höppner (1904a) and Verhoeff (1892) both report that larvae of *Stelis* (*ornatula* Nylander and *minuta* Nylander respectively) consume the body of the host. It was observed that after the presumed first molt, the *Stelis lateralis* larvae were considerable more active than *Hoplitis,* and would bite readily at a needle. Significant observations on the relative aggressiveness of larvae of *Hoplitis* and *Stelis* were made by Graenicher (1905).

While killing the *Hoplitis* larva or immediately thereafter the *Stelis* changes from its head up position in the pollen to a horizontal or, very soon, a head down position on top of the pollen and feeds downward on one side of the pollen mass, eventually eating most or all of it. This downward feeding stage required 13 to 17 days in the three individuals for which the data were obtained, and as this stage progressed the larvae became more and more robust. The number of molts in this portion of larva life was not determined.

The deposition of the egg near the base of the cell as well as the movements of the larva, including destruction of the host after the *Stelis* is partly grown, are characteristic not only of *Stelis lateralis* but also of *S. minuta* (see Verhoeff, 1892) and *S. ornatula* (see Höppner, 1904).

As in various other bees, fecal pellets of *S. lateralis* are voided through a considerable part of the larval life. As with *Megachile brevis* there is variation

as to the time of appearance of the first feces. In one case ten pellets were produced and left in the lower part of the cell before the larva reached the surface of the food mass and killed the *Hoplitis*. In most cases feces did not appear until the larva had assumed a head downward position. The feces (pellets about 0.5 mm. long) were then deposited on the upper parts of the walls of the cells. As has been pointed out by Verhoeff (1892) and others, many bee larvae defecate well before termination of feeding. In this respect they differ from *Apis* as well as from various wasps.

At the end of the feeding period, when the *Stelis* larvae were probably 17 to 21 days old, cocoon spinning began. This process took 3 or 4 days. First to be spun was a very light network of white fibers which excluded all fecal pellets and other loose material from the vicinity of the larva. Inside and supported by these loose threads the cocoon proper was spun. At first its was transparent enough that the regular side to side spinning movements of the larva could be seen but by the third day of spinning in each cocoon studied it was opaque and white. On the fourth day it became brown due to an amorphous material presumably deposited as a liquid on the inner wall of the cocoon. Among the individuals in the nest, cocoon spinning was completed from June 30 to July 18.

STRUCTURE OF THE *Stelis* COCOON. There is now considerable evidence that cocoon structure in the Megachilidae, although somewhat variable within a species as shown by Michener's (1953) studies of *Megachile brevis*, nonetheless will provide interesting characters. The following description is based upon a single cocoon of *Stelis lateralis*:

Length 6.5 mm. of which 0.75 mm. is a nipple at one end; width 2.5 mm. The loose, outer fine white threads first laid down by the larva connect the outer surface of the cocoon to the inner wall of cell, fecel pellets, etc., at many points. The nipple, however, is free of such connections. The outer cocoon consists of a thin meshwork of similar fine white threads, impregnated with an amorphous whitish translucent material which closes all spaces between the threads and forms a tight sheath except for a small opening (0.13 mm. in diameter) at the apex of the nipple. Here the liquid substance which hardens into the membrane of the outer cocoon evidently was not applied. A few silk threads cross this space but the spaces between them are open. The nipple is slightly brownish, not as pale as rest of the outer cocoon.

There are some loose fine white silk threads connecting the outer cocoon with the inner. Evidently they were laid down after the application of the liquid white material of the outer cocoon but somehow were not involved with the brown liquid of the inner cocoon. For this reason the outer cocoon can be easily separated from the inner cocoon. The former is relatively delicate while the latter is tough.

The inner cocoon consists of a thin meshwork of fine silk threads, doubtless originally the same as those of the outer cocoon, now imbedded in a dark brown amorphous material which must have been applied as a liquid and which gives the inner cocoon the appearance of a muscoid puparium. The nipple again lacks this sealing substance, there being an opening .17 mm. in diameter filled with a dense mass of threads but not sealed. There is no evidence of various layers in the inner cocoon.

The diameters of threads range from 0.1 to .005 mm. in both cocoons. Except for thicker individual threads, the thickness of the outer cocoon is not over .005 mm. that of the inner cocoon less than .02 mm.

Striking differences between the *Stelis* cocoon and that of *Megachile brevis* include the presence of the nipple in the former (represented in *Megachile* only by an inconspicuous ventilating (?) place), the absence of an amorphous sealing material in the outer cocoon of *Megachile*, the coarse fibers of the outer cocoon of *Megachile*, and the restriction of this outer cocoon to one end of the whole cocoon in *Megachile*. The cocoon of *Coelioxys* resembles that of *Megachile* except that its outer layer is complete (see Michener, 1953).

The adult *Stelis* emerged in the spring of 1952, destroying their cocoons and the partitions between the cells in so doing.

SUMMARY OF LIFE HISTORIES OF *Hoplitis* AND *Stelis*. The meager data presented here together with field collecting data for the *Hoplitis* indicate that both species have but one generation per year. The adults are active in May and June. *Hoplitis* females construct nests in pithy stems. Whether one female makes more than one nest is unknown. The cells are provisioned with pollen largely from small flowered legumes in this region. Larvae of both genera probably complete their feeding by midsummer and construct cocoons in which they presumably pass the winter, pupating in the spring.

Stelis lateralis is an inquiline in the *Hoplitis* nests, laying its eggs in the pollen masses of the *Hoplitis* cells. In their second stadium the *Stelis* larvae kill those of the *Hoplitis*.

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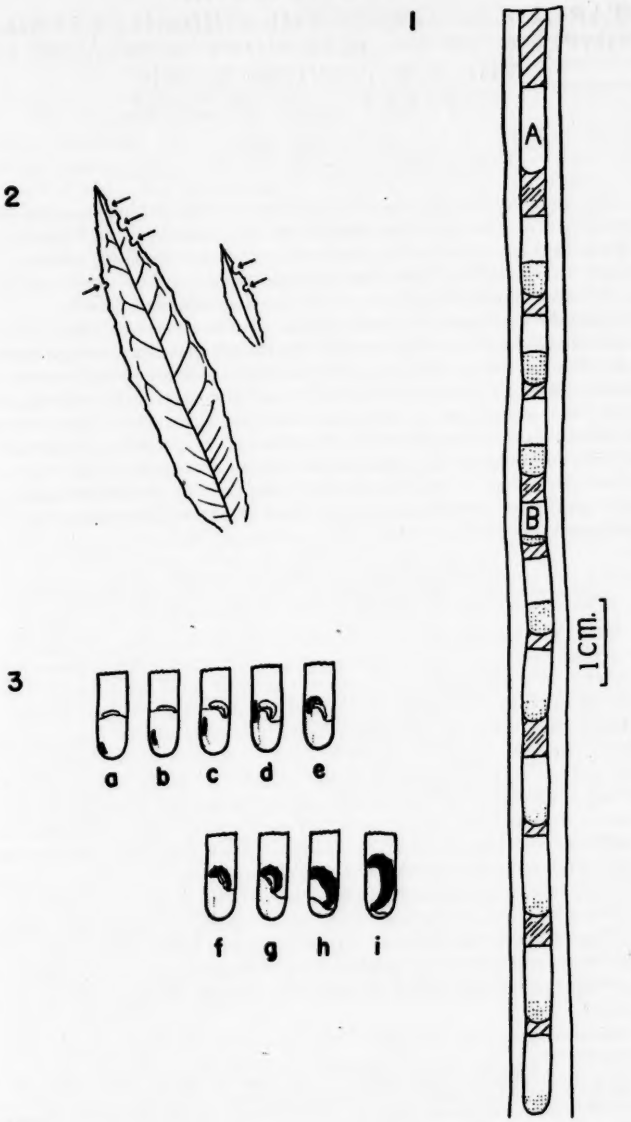
EXPLANATION OF FIGURES

1. The nest in sectional view. Stippling represents food stores. Diagonal lines widely spaced represent plugs or partitions made of chewed leaf material; diagonal lines closely spaced represent portions of partitions made of bits of pith. A was an empty space while B (which was started as a cell to judge by the small amount of stored food) was loosely filled with bits of pith and chewed leaf material.
2. Leaves of *Oenothera* (one very young) showing pieces removed by *Hoplitis pilosifrons*. (Drawn at half the scale of figure 1)
3. Diagrams of a *Hoplitis pilosifrons* cell parasitized by *Stelis lateralis*. The egg and larva of the *Hoplitis* are white, those of the *Stelis*, black. Eggs are shown in a; in b, c, and d the *Hoplitis* feeds in typical megachilid fashion while the *Stelis* feeds as it burrows upward, leaving a recognizable channel behind it; in e the *Stelis* attacks and kills the *Hoplitis*; in the remaining diagrams the *Stelis* feeds in typical megachilid fashion.


1
A
B
1 cm.
2
3
a b c d e
f g h i

NEARCTIC SPECIES IN THE *LIRIOMYZA PUSILLA* COMPLEX. NO. 3 *L. ALLIOVORA*, NEW NAME FOR THE IOWA ONION MINER (DIPTERA: AGROMYZIDAE)[1]

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The larvae of a fly, identified as *Agromyza pusilla* Meigen, were found damaging onion leaves in Iowa by Harris and Tate (1933). This record appears to be the only one of an agromyzid leaf miner attacking onions in the United States. In 1943 Frost decribed several new species closely related to *pusilla* and one, including the Iowa onion miner, was named *allia*.

I had the opportunity to study the holotype male of *allia* and a paratype male bearing the same collection data, and to compare these with specimens reared from onion in the Iowa State College collection. Unfortunately the specimens from onion were different from the holotype. C. W. Sabrosky then sent me seven paratypes from his personal collection. Each of these proved to be different from either the holotype or the reared specimens. Therefore, on the basis of the specimens that I have seen, I hereby restrict the name *allia* to the holotype and a topotypical male, designate the specimens reared from onion as *alliovora* new species, and exclude the remaining specimens, designated paratypes by Frost, from either species (Table 1).

Liriomyza alliovora new species

Agromyza pusilla (Meigen), Harris and Tate, 1933, Jour. Econ. Ent. 26:515.
Agromyza (*Liriomyza*) *allia* Frost p. p., 1943, Jour. N. Y. Ent. Soc. 51:253.

MALE. Subshining yellow and black. Head yellow, ocellar triangle and occiput black, black not reaching eye margin but attached to ocellar triangle; both vertical setae arising from yellow; antenna with arista black. Thorax with mesonotum subshining black, lightly covered with gray granules in certain lights, black not extending laterally to humerus or presutural seta, curving strongly mesally at transverse suture, supraalar seta on black, at edge, outer postalar on yellow, at edge of black, inner postalar on yellow—the black curving around this seta and nearly reaching scutellum, as broadly as width between dorsocentral setae; scutellum with small black triangles, basal scutellar setae arising from yellow, at edge of black; humerus with very small black spot, humeral seta arising from yellow; anepisternum yellow with small black triangle anteroventrally, about one-third height and one-half width of anepisternum; katepisternum with small black triangle, no posterior marking; meropleurite about one-half black; pteropleura with a single narrow black stripe anteriorly. Legs with coxae and femora very faintly brown basally, otherwise yellow; tibiae and tarsi light brown. Wings hyaline; margin

[1] Scientific Paper No. 1350, Washington Agricultural Experiment Stations, Pullman Project No. 1062.

[2] I wish to thank H. M. Harris and J. L. Laffoon, Iowa State College, and C. W. Sabrosky, U. S. National Museum, for the loan of specimens. I am indebted to C. W. Sabrosky and R. H. Foote, U. S. National Museum, and M. T. James, State College of Washington, for reviewing the manuscript.

and fringe of calypter dark. Abdomen with tergites broadly yellow laterally (nearly all of abdomen visible in lateral view is yellow), dorsally first two subshining black, third to sixth each with a wider posterior yellow band, sixth tergite with only a small black spot anteriorly; ninth tergite yellow dorsocentrally, otherwise dark brown, cerci yellow.

Head: In lateral view as in left figure. Gena, midway between vibrissal angle and posterior margin, nearly one-fifth eye height; eye large, nearly one and one-half times as high as long; genoventrical plate only slightly raised above eye margin, ventral lower dorsocentral seta subequal to dorsal lower dorsocentral, about five orbital setulae on either side. Antenna with third segment rounded, broader than long; setulae less than basal aristal thickness; arista about as long as eye width, slightly swollen on basal fifth.

Thorax: Four dorsocentral setae; fourth the longest, third two-thirds as long, first and second subequal, about one-half the fourth; fourth slightly farther removed from third than second is from first, second and third closest together, about three-fifths as far as fourth is from third; about six setae in the intraalar row posterior to transverse suture, intraalar present on one side, subequal to an acrostichal in length; inner postalar about one-half as long as the outer postalar; acrostichal setae about 13 in number, in four sparse irregular rows, extending posteriorly nearly to third pair of dorsocentrals; humeri each with three or four setulae plus the humeral.

Wing: About twice as long as wide. Costa terminating at wing tip, second segment nearly three times as long as third; third and fourth subequal in length; m - m cross vein about one and one-fourth its length from r - m, perpendicular to penultimate section of M_{1+2}; ultimate section of M_{1+2} about nine times the penultimate; ultimate section of M_{3+4} nearly three times the penultimate.

Size: Wing length, 1.2 mm.

FEMALE. Larger, wing length 1.5 mm. head with gena one-fourth eye height; thorax with 15 acrostichals, five and six setulae in the intraalar rows, an intraalar present on either side, subequal to an acrostichal in length; wing with second costal segment four times length of the third; m - m cross vein at a moderate angle to penultimate section of M_{1+2}; abdomen with all tergites except first with a broad posterior band of yellow, first very narrow, seventh segment conical, truncate, shining black.

Holotype ♂: AMES, IOWA, June 8, 1932, H. M. Harris collector, ex leaf of onion, deposited in the U. S. National Museum. *Allotype* ♀: Topotypical, July, 1931, H. M. Harris, ex leaf of onion, also deposited in the U. S. National Museum. *Paratypes:* All topotypical, 2 dated July, 1931, and 17 dated June 8, 1932 (4 bear a label reading: Pupated May 30, Emerged June 5), all reared from onion by H. M. Harris. Paratypes have been deposited in the collections of the U. S. National Museum, Iowa State College, Zoologisches Museum, Berlin, and the writer.

The known North American species in the *pusilla* complex are listed by Frick (1955). *L. alliovora* belongs to the group having both pairs of vertical setae arising from yellow. As *alliovora* has four irregular rows of acrostichal setae it can be separated quickly from *congesta* Becker, 1903, *phaseolunata* Frost, 1943, and *allia* Frost s. s., 1943, each of which has two rows. The black

of the occiput does not reach the compound eyes in *alliovora* (Fig. 1) as it does in *pusilla* Meigen s. s., 1830, *congesta*, and *phaseolunata*.

Liriomyza allia (Frost)

Agromyza (Liriomyza) allia Frost s. s., 1943, Jour. N. Y. Ent. Soc. 51:253.

MALE. Dull yellow and black. Head yellow, ocellar triangle and occiput black, black of occiput neither reaching eye margin nor attached to ocellar triangle; both vertical setae arising from yellow; antenna with arista black. Thorax with mesonotum dull black, heavily covered with gray granules (pollinose), black not extending laterally to humerus or presutural seta, curving strongly mesally at transverse suture, supraalar seta on black, in from edge, outer postalar on yellow, at edge of black, inner postalar on yellow—the black curving around this seta and reaching base of fourth dorsocentral seta and nearly reaching scutellum, narrower than width between dorsocentral setae; a light brown stripe extending from anterior of inner postalar nearly to transverse suture; scutellum with relatively small black triangles, basal scutellar setae arising from black, at edge; humerus with very small black spot, humeral seta arising from yellow; anepisternum yellow with minute oval spot midway along ventral margin, katepisternum with small black triangle, no posterior marking; meropleurite about one-half black; pteropleura with a single narrow black stripe anteriorly. Legs with coxae very faintly brown basally, othewise yellow; tibiae and tarsi light brown. Wings hyaline; margin and fringe of calypter dark. Abdomen with tergites broadly yellow laterally (nearly all of abdomen visible in lateral view is yellow), dorsally first two dull black, third to sixth each with a wider posterior yellow band, sixth tergite with only a small black spot anteriorly; ninth tergite yellow dorsocentrally, otherwise dark brown, cerci yellow.

Head: In lateral view as in right figure. All setae short. Gena, midway between vibrissal angle and posterior margin, nearly one-fourth eye height; eye small, two-thirds as long as high, genovertical plate moderately raised above eye margin, ventral lower dorsocentral seta minute, about one-half the length of the upper lower dorsocentral; about two or three orbital setulae on either side. Antenna with third segment rounded, broader than long, setulae minute; arista about as long as eye width, swollen on basal one-fourth.

Thorax: All setae short; four dorsocentral setae, fourth slightly the longer (first and second only five-sixths as long as fourth, third missing in this specimen); about two or three setulae in each intraalar row posterior to transverse suture, intraalar absent; inner postalar about one-third as long as the outer postalar; acrostichal setae about five or six in number, in two sparse irregular rows, extending posteriorly a little past the second pair of dorsocentrals; humerus with two or three setulae plus the humeral.

Wing: About twice as long as wide. Costa terminating at wing tip, second segment nearly three times as long as third; fourth about three-fourths as long as third; m-m cross vein about three-fourths its own length from r-m, at a moderate angle to penultimate section of M_{1+2}; ultimate section of M_{1+2} about twelve times the penultimate; ultimate section of M_{3+4} about three times the penultimate.

Size: Wing length 1.2 mm.

TABLE 1. Disposition of Specimens Studied that are Labeled: Paratype, *Liriomyza allia* Frost

Place	Specimen Date	Collector	From Collection of:	Excluding Characters and Notes
Manhattan, Kansas	V1-9-1934	C. W. Sabrosky	U.S.N.M.	Male—same as holotype of *allia*, topotypical
Ames, Iowa	V11- -1931	H. M. Harris	U.S.N.M.	Female—allotype of *alliovora*
Ames, Iowa	V11- -1931	H. M. Harris	Iowa State College	Male—paratype of *alliovora*
Ames, Iowa	V11- -1931	H. M. Harris	Iowa State College	Abdomen missing—paratype of *alliovora*
Manhattan, Kansas	V1-6-1930	D. A. Wilbur	C. W. Sabrosky	Basal scutellar setae arising within black triangles
Manhattan, Kansas	V-7-1934	D. A. Wilbur	C. W. Sabrosky	Anepisternum about one-half black
Manhattan, Kansas	V-7-1934	D. A. Wilbur	C. W. Sabrosky	Anepisternum about one-half black
Manhattan, Kansas	V-7-1934	D. A. Wilbur	C. W. Sabrosky	Anepisternum about one-half black
East Lansing, Michigan	V1-1-1937	C. W. Sabrosky	C. W. Sabrosky	Acrostichals in two rows as in *allia*, eye proportioned as in *alliovora*
Medora, Kansas	IV-17-1932	C. W. Sabrosky	C. W. Sabrosky	Third antennal segment angulate
Kalamazoo, Michigan	V-10-1936	C. W. Sabrosky	C. W. Sabrosky	Third antennal segment angulate

Redescribed from a topotypical paratype male (Table 1) that is similar in all respects to the holotype male. *L. allia* has only two irregular rows of acrostichals. This serves to separate it easily from *alliovora*. Two other North American species belong to the group having the two acrostichal rows. These are *congesta* Becker, 1903, and *phaseolunata* Frost, 1943, and both differ from *allia* in having the black of the occiput reaching the compound eyes.

From a glance at Table 1 it is obvious that there are more species that do not have the black of the occiput reaching the compound eyes and have both vertical setae on yellow than *allia* and *alliovora*. However, I am not willing to describe additional species that belong within the *pusilla* complex until I have seen an adequate series of reared specimens of each.

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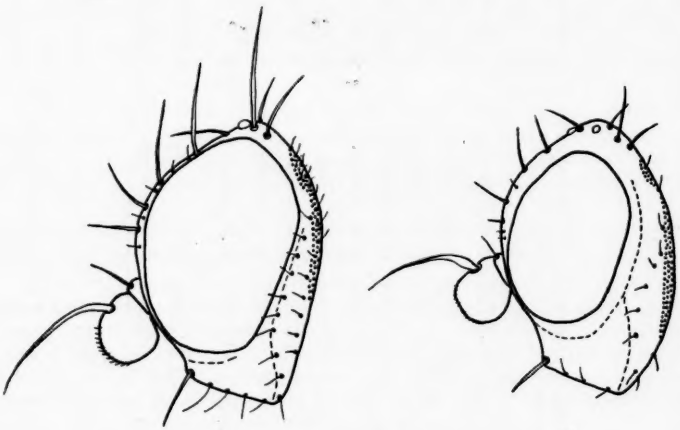

EXPLANATION OF FIGURES

Left. Lateral view of head of holotype ♂ of *L. alliovora* n. sp.
Right. Lateral view of head of paratype ♂ of *L. allia* (Frost).

SEASONAL DICHROMATISM IN *MEROMYZA AMERICANA* FITCH (DIPTERA:CHLOROPIDAE) IN RELATION TO VARIABLE LENGTH OF PREOVIPOSITION PERIOD[1]

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INTRODUCTION

Seasonal dichromatism is well known in Lepidoptera where it is easy to demonstrate since changes in colors are more apparent on the extended surface of the wings of butterflies and moths than on the small bodies of tiny flies. The most intensive experimental work has been done on *Araschnia levana* L. aberr. *prorsa* L. (Weismann 1876, 1896; Merrifield 1911; Süffert 1927; Dorfmeister 1864; Ris 1927, 1930).

Süffert (1927) observed in his experiments that the lighter colored summer forms of *Araschnia levana* were produced when pupation occurred at 15-30°C. The darker winter forms were produced when development during pupation was prolongated ("Latenzperiode"). Winter forms were also produced when the newly formed pupae were exposed to 1 to 10°C during a short and morphologically defined period ("sensible Periode"). Melanotic forms in *Araschnia levana* were also produced when the newly formed pupae were exposed to low temperatures and by this means the development was retarded. Seasonal dichromatism occurs in Hymenoptera, Coleoptera, Heteroptera and Homoptera.

Fernald (1926) reported that in Sphecinae the amount of red present was determined by sex and climate, particularly humidity. In the most humid climates there was the least red. In the semiarid regions the amount of red varied with the varying humidity of different seasons. The greatest number of red colored specimens was found in forms from arid regions. Melanism was also studied in the pentatomid *Perillus bioculatus* Fabr. by Knight (1924). A slight deposit of melanin in the cuticula appears brown, while in greater concentration the pigment appears black. When metabolism is carried on at higher temperatures (30-35°C) white color forms are produced. The decrease of melanin in the color pattern runs parallel with the decrease in deposit of carotin in the hypodermis. Yellow and red pigments are formed in the hypodermal cells. Once the red pigment is laid down in the hypodermis of the adult, it is never diminished. At high temperatures (30-35°C), the

[1] The author wishes to express his gratitude to Dr. R. C. Smith and Dr. Reginald H. Painter for suggestion of the studies carried out under the direction of the latter, to E. T. Jones for the volunteer wheat infested with wheat stem maggots brought into the greenhouse, to Mr. C. W. Sabrosky for reviewing the manuscript.

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This study is a portion of a dissertation presented in partial fulfillment of the requirement for the degree Doctor of Philosophy in Entomology at Kansas State College.

yellow and red colors do not appear. At intermediate temperatures (26-28°C) the color pattern cannot be predicted. At these temperatures the color pattern is largely determined by the individual activity. Most of the females show a white and black pattern, whereas males will be yellow and black or red and black. At temperatures below 26°C the yellow and red color forms appear. In Knight's experiments humidity affected the color pattern only by influencing the physical activity of the bug, which in turn affects metabolism.

SEASONAL DICHROMATISM IN CHLOROPIDS

Several species of the Chloropidae offer a very good opportunity for demonstration of seasonal dichromatism since they occur in more than one generation a year, the summer generation often differing from the winter generation. Furthermore the integument of different species is colored in a wasplike pattern, mostly yellow, reddish or green with black stripes and patches on the head, thorax, and abdomen. The yellow pigments with their greenish or reddish variants are localized in the cells of the hypodermis also in chloropids. They are covered to a lower or higher degree by the black or brown pigment localized in the exocuticle. According to Wigglesworth (1946) the black pigments or so-called melanins are produced by interaction between chromogen + tyrosinase and O_2. The synthesis takes place at loci with high metabolic activity. The yellow pigments, as for instance xanthopterine ($C_{19}H_{19}O_{15}$), are related to purines (*e.g.* uric acid) and are produced in places of low metabolic activity.

Seasonal dichromatism is known in the literature in the gout fly, *Chlorops pumilionis* Bjerk. (Balachowsky and Mesnil, 1935) and in *Meromyza saltatrix* and *M. pratorum* (Rockwood *et al.*, 1947). No indication on seasonal dichromatism in *Meromyza americana* Fitch could be found in the literature.

In the experiments with *Chlorops pumilionis* Bjerk., reported by Horber (1950), winter rye with galls containing larvae were brought at different dates during fall and winter to warm greenhouse conditions. The occurrence of winter forms are demonstrated in Table 1. The larvae were exposed during different periods to low temperatures whereas all the pupae were exposed to the same greenhouse conditions (15°C). The sensitive period for low temperatures or slow development respectively in this chloropid fly seems to lie in the larval stage. This finding is in contrast to the observations of Süffert (1927) who reported the sensitive period in the Lepidopteran *Araschnia levana*, to be in the early pupal stage.

SEASONAL DICHROMATISM IN *Meromyza americana*

In the author's studies of *M. americana*, flies were collected in the larval stages in volunteer wheat at different places in Riley, Pottawatomie and Marshall Counties, Kansas. The flats containing volunteer wheat were brought into the greenhouse at different times during the winter and spring months from November to May. The flies in the larval stage had therefore been exposed first over a shorter or longer period to winter temperatures and then for the remainder of their laval and pupal development period to greenhouse conditions. The emerging adults from each batch were compared to flies

caught in September and October in the agronomy farm and apiary plot and to specimens available in the collection of the Entomology Department of Kansas State College. The flies in the collection were caught by Marlatt, Painter, Popenoe, Sabrosky, Smith, Wilbur. Most of them were determined by Sabrosky. The specimens were arranged as to the date they were collected in the field.

It was also possible to compare the adults emerging from volunteer wheat taken into the greenhouse at different dates during winter time or swept at different dates in the field with flies reared during the spring months from eggs to adults in the greenhouse. The flies emerging during May and the first days of June from wheat plants in the greenhouse had had a relatively short developmental period. The first batch of flies, from eggs laid during the first days of January, emerged at the end of March after a developmental period of 90 days on the average. The second batch, from eggs laid during the last ten days of March, emerged between the last ten days of May and first days of June after an average developmental period of 63 days. The flies reared in the greenhouse from egg to adult may be considered as an intercalary summer generation.

The material inspected included 502 specimens. Those flies reared from volunteer wheat were collected twice a day and exposed in glass tubes together with water and honeydew from apple-grain aphid or sugar syrup. The behavior of flies was observed in tests for training them to come to food on various colors and for the length of preoviposition period. The results from the observations on dichromatism are compiled in Tables 2-5, shown in Fig. 1 and summarized in the following conclusions:

1. The seasonal dichromatism in *M. americana* is due to a lower or higher degree of melanism of the integument of different segments in the head, thorax and abdomen in specimens of the succeeding generations. The highest degree of blackening in the winter form is apparent on the tergites of the abdomen.

2. The blackening of the abdominal tergites spreads from the most distal segment to the most proximal (Table 2). Males in the summer form as well as in the winter form show more infuscated abdominal tergites than females.

3. In the summer form abdominal tergites 2 and 3 are not blackened either in males or in females. In the winter form all tergites in males and females except the first in males and the first and second in females are completely blackened.

4. In the summer forms neither infuscated tips of palpi nor lateral occipital spots could be observed. Only 23 per cent of the flies had humeral spots present. In the winter form infuscated tips of palpi could only be observed in females and then only in 15 per cent of the specimens. Flies with humeral spots present were 3 to 4 times as frequent as in the summer form. Besides that, 35 per cent (females) and 46 per cent (males) of the winter form showed the presence of lateral occipital spots, the latter being more frequent in males than in females.

5. The longer time of development is correlated with a higher degree of blackening, *i.e.*, greater amount of melanism in the exocuticula, and at the same time correlated with a shorter preoviposition period.

6. The intercalary summer form bred from egg to adult on six different wheat varieties in the greenhouse showed intermediate melanism. No melanic forms were produced and a few specimens had very light colors. At the same time the adults of that intercalary summer generation, the larvae of which were not exposed to cold and therefore showed a quick development of 63 and 90 days rspectively, demonstrated a prolonged preoviposition period of 8-15 days instead of 3-5 days as compared to the winter form.

7. The presence of a prolonged preoviposition period in the generation with a short larval development was also reported in *Chlorops pumilionis* Bjerk. in Switzerland (Horber 1950). The flies that emerge from the overwintering generation and have a wide choice of growing summer and winter small grains, particularly summer wheat and summer barley, at the proper stage for oviposition and larval development of the summer generation, start ovipositing as early as 3-5 days after emerging. Flies of the summer generation that emerge shortly before harvest after a short larval development have no cultivated small grains available and start with oviposition only after a diapause of several weeks. The end of the waiting period coincides with the time when the earliest small grain, the winter rye, is available for oviposition. Rye is the preferred winter host plant. This diapause of the adult is the reason that the gout fly in Switzerland has only two generations a year from the lowest part of Switzerland at 300 meters altitude to the upper limit of cultivated spring wheat at an altitude of 1700 m. In contrast to that, the frit fly, *Oscinella frit* L., according to Roos (1937) apparently without diapause, produces 3-4 generations at 440-460 m., 3 generations at 914 m., 2 generations at 1425 m. and 1 generation at 1866 m. altitude.

PHYSIOLOGICAL SIGNIFICANCE OF SEASONAL DICHROMATISM

The presence of more or less melanin in the exocuticle is an indicator of differences in the metabolism of the summer and winter forms. Further studies should be made by physiologists, *e.g.* to determine whether the flies of the winter form, which apparently are able to handle metabolites in a manner other than that of the summer flies, are also in a position to handle toxicants such as insecticides in a manner different from the summer forms. Furthermore, it should be clarified whether flies developing on different varieties of wheat and other host plants differ in the coloration. It is possible that flies developing on resistant varieties show slower development and therefore also a higher degree of melanism.

FIGURE 1.

Meromyza americana Fitch—Dorsal views of two individuals illustrating the seasonal dichromatic forms.

TABLE 1. Different Degrees of Melanism in Adults of *Chlorops pumilionis* Bjerk. After Exposure of Larvae and Puparia to Different Temperatures (from Horber, 1950)

Date of transfer to the greenhouse	Date of emergence of fly	Length of developing period in days	Days of exposure of larvae and puparia to temp. (°C) 10.5°	3.2°	2.5°	<15°	Melanism* males s	i	w	females s	i	w
October 20	Jan. 5-10	100	20	....	....	80	10	....	....	12	....	....
November 20	Jan. 20-30	110	30	20	....	60	8	1	....	2	9	
December 20	Jan. 31-Febr. 10	120	30	30	20	40	....	3	6	....	....	11

*w = winter form; i = intermediate form; s = summer form.

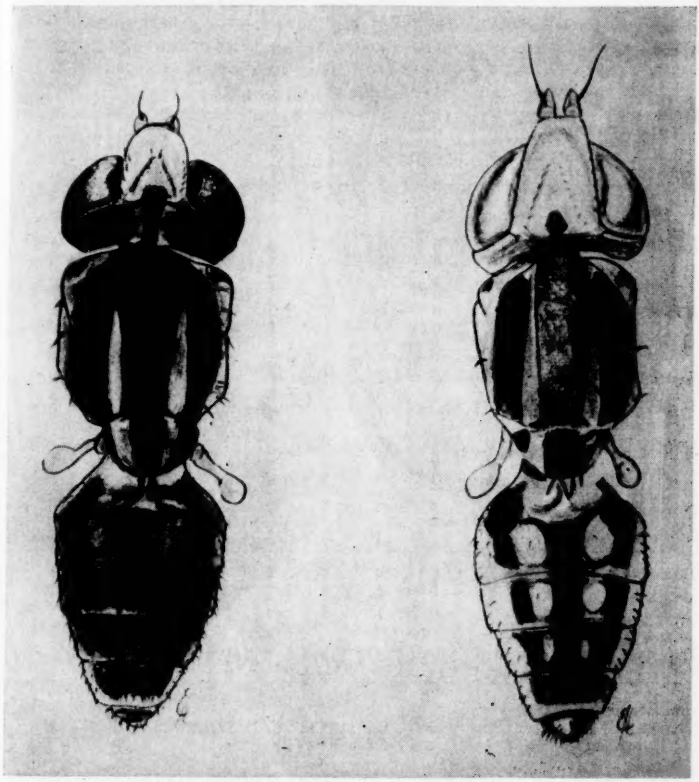

TABLE 2. Degree of Melanism in 375 Adults of *M. americana* Depending on the Date of Emergence. Flies Were Swept in the Field or Emerged from Volunteer Brought into the Greenhouse at the Dates Listed.

Time of emergence	Sex	Abdomen blackened from rear to segment number: 2	3	4	5	6	Total no. of flies	Palpi infuscated	Humeral spot	Lat. occip. spot
January	♂	0	6	17	8	0	31	0	31	22
	♀	0	1	8	9	0	18	2	12	11
	total	0	7	25	17	0	49	2	43	33
February	♂	6	10	11	2	0	29	0	29	20
	♀	0	10	13	0	0	23	11	23	20
	total	6	20	24	2	0	52	11	52	40
March	♂	8	8	10	0	0	26	0	26	26
	♀	0	8	17	0	0	25	12	25	25
	total	8	16	27	0	0	51	12	51	51
April	♂	2	12	19	1	0	34	0	33	32
	♀	0	10	20	0	0	30	11	30	28
	total	2	22	39	1	0	64	11	63	60
May	♂	8	11	17	0	0	36	0	35	35
	♀	0	6	8	1	0	15	2	13	12
	total	8	17	25	1	0	51	2	48	47
June	♂	0	0	4	20	2	26	0	3	0
	♀	0	0	1	21	4	26	0	4	0
	total	0	0	5	41	6	52	0	7	0
July	♂	0	0	0	5	0	5	0	2	0
	♀	0	0	0	8	3	11	0	1	0
	total	0	0	0	13	3	16	0	3	0
August	♂	0	0	0	2	0	2	0	2	0
	♀	0	0	0	1	1	2	0	1	0
	total	0	0	0	3	1	4	0	3	0
September	♂	0	0	1	3	0	4	0	3	0
	♀	0	0	0	2	0	2	0	2	0
	total	0	0	1	5	0	6	0	5	0
October	♂	0	2	0	0	0	2	0	1	0
	♀	0	0	0	2	0	2	0	0	0
	total	0	2	0	2	0	4	0	1	0
November	♂	0	4	3	0	0	7	0	7	4
	♀	0	4	11	2	0	17	5	11	9
	total	0	8	14	2	0	24	5	18	13
December	♂	0	0	0	0	0	0	0	0	0
	♀	0	0	1	1	0	2	1	2	0
	total	0	0	1	1	0	2	1	2	0
Winter form (Oct.-May) ♂/♀	total	24/0	53/39	77/78	11/15	0	165/132	0/44	162/115	139/105
Summer form (June-Sept.) ♂/♀	totals	0	0	5/1	30/32	2/8	37/41	0	10/8	0
Totals of ♂/♀		24/0	53/39	82/79	41/47	2/8	142/173	0/44	172/123	139/105
Total ♂ and ♀		24	92	161	88	10	375	44	295	244

TABLE 3. Seasonal Dichromatism in *M. americana*

Time of emergence	Sex	Percentage of flies with Abdomen blackened from rear to segment number: 2	3	4	5	6	Infuscated tips of palpi	Humeral spots present	Lateral occipital spots present
Summer form	♂	0	0	6.5	38.5	2.5	0	12.8	0
(June- Sept.)	♀	0	0	1.2	41.0	10.2	0	10.3	0
Winter form	♂	8.1	17.9	26.0	3.7	0	0	54.2	46.5
(Oct.-May)	♀	0	13.1	26.2	5.0	0	14.8	38.5	35.2

TABLE 4. Seasonal Dichromatism in *M. americana*
Comparison of Winter Form Emerging in May from Volunteer Wheat Brought into Greenhouse Conditions During April and May with Summer Form of Flies Reared from Egg to Adult Under Greenhouse Conditions from March and May.

Form	Sex	Percentage of flies with abdomen blackened from rear to segment number: 2	3	4	5	6
Winter form: Adults emerged						
from volunteer brought into green-	♂	13.5	18	28	0	0
house during April and May,	♀	0	25	13.5	2	0
larvae exposed to cold.	00	13.5	43	41.5	2	0
Summer form: Adults bred from	♂	0	0	27	27	0
eggs on wheat varieties in the	♀	0	0	22	22	2
greenhouse from March to May.	00	0	0	49	49	2

TABLE 5. Correlation between Preoviposition Period, Degree of Melanism and Time of Development

Time of emergence	No. ovipositions	Time of development (days)	Average length of pre-ovipos. period (days)	Shortest preovipos. period (days)	Percentage of flies with Blackened abd. to segment 2	3	4	5	6	Palpi infuscated	Humeral spot	Lat. occipital spot
Jan.	11	70-100	8.7	8	0	14	51	34	0	4	88	67
Feb.-Mar.	40	100-160	6.2	3	14	35	50	2	0	23	100	88
April	29	160-190	5.6	3	3	34	60	2	0	17	98	94
May	11	190-210	4.1	3	16	33	50	1	0	4	96	94

SUMMARY

Seasonal dichromatism was demonstrated to occur in close parallel with differences in the length of the preoviposition period. Flies emerging from volunteer wheat or swept in the field from October to May showed a greater

degree of blackening on head, thorax and on the tergites of the abdomen. They also had a short preoviposition period of only 3 to 5 days. Flies emerging after a short larval period from June to September and those of an intercalary summer generation bred in the greenhouse showed either the absence or a smaller extent of blackened areas on head, thorax and tergites of the abdomen. They had a longer preoviposition period varying between 8 and 16 days. There is a short discussion on the physiological significance of seasonal dichromatism: the succeeding generations might differ in their susceptibility to insecticides or flies emerging from resistant varieties might show a higher degree of melanism.

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THE LONE STAR TICK (*Amblyomma americanum* (L.)) IN RHODE ISLAND

JOHN A. MATHEWSON[1]

An unengorged tick found crawling on the writer's neck on July 14, 1954, after an afternoon spent in a secluded wooded area near the Village of Rockville, Town of Hopkinton, Washington County, Rhode Island, proved to be an adult female Lone Star Tick (*Amblyomma americanum* (L.)). The specimen was examined by and determination confirmed by Doctors K. E. Hyland (University of Rhode Island), George Anastos (University of Maryland), and Glen Kohls (Rocky Mountain Laboratory, Nat'l Inst. Health). It has been deposited in the collection of the Rocky Mountain Laboratory.

Attempts to collect further specimens by sweeping the area proved fruitless.

Miss Helen Sollers (USDA, Economic Insect Survey Section) reports (*in litt.* Sept. 24, Oct. 4, 1954) that one specimen of this tick was reported to the Survey from Rhode Island in 1943 by the late Brayton Eddy. The data card bears only the names of the tick, the reporter, the state, the year, and a comment by Miss Gertrude Myers concerning the newness or rarity of the record. Data on the determiner, exact date and locality, sex, and state of engorgement are absent. The report was apparently not published and is unmentioned in Eddy's Rhode Island report for 1943.

There are but few recent records of the occurrence of this tick north of New Jersey and Pennsylvania. Bequaert (1946) cited three Massachusetts records which he viewed as "evidently stray specimens imported accidentally from farther South". Rehn (1953) reported the occurrence of a single individual on Staten Island, New York, and suggested that this tick "may now be established on Staten Island".

Pending further data it would seem advisable to consider the Rhode Island specimens as accidental strays from farther South.

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A STUDY OF MOTHS CAPTURED AT A LIGHT TRAP AT WESLACO, TEXAS[1]

PAUL T. RIHERD AND GEORGE P. WENE[2]

This paper is based upon studies of moths collected in a light trap during the period of March 1, 1953, to February 28, 1954. The modified Minnesota trap was operated on the grounds of the Texas Agricultural Experiment Station, Substation 15, Weslaco, Texas.[3] Instead of a single incandescent bulb lamp in the opening at the intersections of the baffles as there is in the Minnesota trap, the baffles are left solid and a 15 watt, "black-light," tubular lamp is placed upright in the corner of each quadrant of the baffles.

The object was to make a preliminary study of the species present and the seasonal occurrence of the moths of this area. It was assumed that, in general, if a species is common and is strongly attracted to the light in use, sufficient individuals would be caught to demonstrate the occurrence of a regular flight. Daily fluctuations caused by variations in weather conditions should not alter the final results where the daily catch is expressed in monthly totals.

The killing jar used was a standard one-half gallon fruit jar charged with flaked calcium cyanide. The killing jar was placed on the trap each day at 5:00 p.m. and removed at 8:00 a.m. the next morning. The night's catch was removed from the jar and placed in a paper sack to allow the cyanide fumes to dissipate during the day. In the evening the catch was spread on a newspaper and separated to the species. When the catch was so large that time would not permit the separating and counting of the entire catch, it was examined for rare or unusual species and then the remainder of the catch was divided into four equal parts. The number of each species from this portion was multiplied by four and the total recorded as the number for the night's catch.

Daily records were made of 40 species for the entire year. The totals of the daily catch of these species for each month are tabulated in Table 1. The scientific names appear in the order as listed in: McDunnough, J., Check List of the Lepidoptera of Canada and the United States of America, Southern California Academy of Science Memoirs, Part I, 1938; Part II, 1939. Exceptions to this procedure were made when a species is not listed in the paper. In a few instances, a change in a name was made when it had been placed in synonomy.

These data show that Lepidoptera are active throughout the year in the Lower Rio Grande Valley of Texas. It is interesting to note that large collections of the cabbage looper, *Trichoplusia ni,* were taken every month. Moths of the corn earworm were also collected during every month; however, the

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[1] Approved by the Director as Technical Article 1976, Texas Agricultural Experiment Station.

[2] Formerly Associate Entomologist, and Entomologist respectively, Texas Agricultural Experiment Station, Substation 15, Weslaco, Texas.

[3] The trap was constructed by J. P. Hollingsworth, Associate Engineer, U.S.D.A. Agricultural Research Service, Engineering Research Branch, College Station, Tex.

number collected was much smaller for the months of October, November, and December. A large number of moths was collected during January. It is interesting to note that the corn earworm caused severe damage to lettuce during January and February, months which in the past have been considered to be free from the corn earworm. The catches show that heavy populations of earworm moths are present when sweet corn is silking during the months of April and May. Severe earworm damage to sweet corn in this area is to be expected. The fall army worm, *Laphygma frugiperda,* was present throughout the year with the peak occurring in October.

The black cutworm, *Agrotis ypsilon,* and the granulated cutworm, *Feltia subterranea,* were numerous in January and February and reached the peak in March and April. These dates coincide with the dates in which cotton and other early spring planted crops are in the stage of development susceptible to cutworm damage.

The available time did not permit the identification and counting of the daily catch of all specimens captured. Rare or unusual species, or species that were recognized not to have been identified previously were retained for future identification. Some species of Microlepidoptera were considered only after they became regularly numerous in the daily catch. A considerable number of the species of Microlepidoptera and some of the smaller Macrolepidoptera were not identified. The species of which daily records for the entire year were not made are listed in Table 2. In this table, the first figure in each group following the name of the species is the month; the total number of the species identified for the month is given in parentheses.

The first specimen of the cotton leafworm moth, *Alabama argillacea,* was taken on June 2 and continued to be caught until December 4. The first recorded pink bollworm moths were captured June 27 and continued to be present until September 27. The total catch was very heavy during the first part of June, and no doubt this was not the very first specimen to be caught; but due to the small size and small number, they were not found.

During the period covered by this study, the fruit piercing moths destroyed up to 80% of the orange crop in a section of Mexico south of the location of this trap. The Texas citrus crop may have narrowly escaped economic damage from these moths. A moth of this group, *Gonodonta pyro* Cram., was taken in limited numbers in July, September and October. Personnel of the U.S.D.A., Mexican Fruit Fly and Citrus Blackfly Project at Harlingen, Texas, found that the moth, *Gonodonta bidens,* was the species damaging the citrus in Mexico. One specimen of this species was taken in the trap at Weslaco on January 1, 1954.

Acknowledgment is made to members of the U.S.D.A., Agricultural Research Service, Entomological Research Branch, Section of Insect Detection and Identification, for identification of species. Determinations were made by the following individuals: J. G. Franclemont, J. F. G. Clarke, W. D. Field, E. L. Todd, and H. W. Capps.

TABLE 1. Monthly Totals of Moths Captured from March 1, 1953, Through February 28, 1954

	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.
Phlegethontius sexta Joh.	41	54	70	49	23	38	64	27	15	5	1	3
Phlegethontius quinquemaculata Haw.	16	29	5	7	3	12	15	1	0	0	0	0
Phlegethontius rustica F.	1	0	0	0	0	3	2	0	0	0	0	0
Erinnyis ello L.	6	1	5	14	25	118	35	43	10	4	1	1
Erinnyis obscurea F.	24	116	66	51	71	93	155	189	217	77	59	23
Celerio lineata F.	237	246	121	65	4	1	78	65	30	4	6	430
Automeris io F.	4	3	3	0	1	0	20	2	7	4	30	58
Adelocephala heiligbrodti Harv.	18	28	11	12	5	7	31	9	0	0	0	4
Halisidota cinctipes Hy. Edw.	27	0	0	1	0	0	1	0	0	0	0	19
Apantesis phalerata Harr.	79	155	51	21	5	1	5	18	9	3	12	34
Estigmene acrea Dru.	16	18	3	21	3	3	44	134	54	2	79	120
Ecpantheria muzina Oberth.	77	31	51	57	2	0	10	29	26	6	8	19
Agrotis malefida Gn.	77	1	16	2	28	8	212	42	60	55	185	123
Agrotis ypsilon Rott.	3269	602	433	135	96	0	87	232	301	616	1917	2104
Feltia subterranea (F.)	2281	3137	1613	1181	395	146	186	726	310	524	2107	164
Hemieuxoa rudens Harv.	9	18	1	4	0	0	0	1	36	57	51	4
Peridroma margaritosa Haw.	173	9	12	17	8	0	36	40	429	425	451	254
Lycophotia infecta (Steph.)	165	14	233	38	4	0	16	0	93	145	451	254
Lacinipolia erecta Wlk.	140	12	1	0	0	0	16	0	0	5	7	166

Leucania latiuscula H. - S.	60	2	3	5	0	0	12	28	227	157	294	64
Pseudaletia unipuncta Haw.	429	10	4	349	109	20	3136	820	1414	797	506	1516
Leucania humidicola (Guen.)	518	305	101	77	14	12	40	52	55	103	77	76
Platysenta videns Gn.	51	5	20	4	20	4	32	144	73	117	105	114
Prodenia ornithogalli Gn.	51	9	29	144	65	76	500	412	550	263	2312	433
Laphygma frugiperda A. & S	6	1	1	10	305	196	1100	2124	465	493	376	32
Magusa orbifera Wlk.	94	2188	299	102	65	64	1154	4588	909	446	168	183
Xerociris Wilsoni Grt.	67	37	39	39	58	164	540	200	0	0	0	34
Heliothis armigera Hbn.	444	269	243	1154	571	550	1158	128	101	51	582	2149
Trichoplusia ni (Riley)	1361	694	801	807	771	1090	3152	723	556	72	122	122
Autographa biloba Steph.	72	0	19	15	5	0	7	82	269	294	636	3338
Melipotis indomita Wlk.	5	91	177	435	466	316	440	324	159	34	112	64
Melipotis jucunda Hbn.	104	96	63	25	15	41	108	60	1414	797	506	1516
Melipotis acontioides Gn.	19	435	200	223	447	424	1029	630	300	251	183	353
Bulia similaris Rich.	9	85	526	1224	974	1534	1037	442	104	4	125	127
Plathypena scabra F.	18	9	0	1	0	0	16	0	1	0	14	4
Cerura cinerea Wlk.	35	53	60	76	126	118	358	140	129	12	93	363
Semiothisa s-signata Pack.		7322	3038	404	261	350	2620	7468	593	7	66	1195
Megalopyge opercularis A. & S.	36	288	236	20	4	16	336	0	0	0	32	1
Nomophila noctuella D. & S.	184	37	15	21	0	4	4616	1972	4800	3693	233	1545
Prionoxystus robiniae Peck.	107	2	0	0	0	0	3	7	8	3	25	32

TABLE 2. Records of Moths Captured at Light Trap Without Complete Record for the Year. The First Figure is the Month. Total Number of the Species Identified is in Parentheses

Ceretomia undulosa Wlk. 6(2) 7(1) 8(2) 9(11) 10(9) 11(2) 1(1) 2(8)
Sphinx libocedrus Hy. Edw. 2(2)
Erinnyis alope Dru. 8(4) 9(1) 10(1) 12(1)
Pachylia fiscus L. 2(1)
Enyo lugubris L. 3(1) 7(1) 9(1) 10(1)
Pholus satellitia pandorus Hbn. 7(1)
Pholus vitis L. 4(4) 5(7) 6(5) 7(6) 8(1) 9(5) 10(7) 11(6)
Pholus fasciatus Sulz. 3(1) 4(1) 5(1) 10(1)
Pholus labruscae L. 10(1)
Xylophanes pluto F. 10(1)
Xylophanes tersa L. 3(6) 4(3) 5(5) 8(1) 9(11) 10(5) 1(1) 2(4)
Telea polyphemus Cram. 5(1)
Syntomeida ipomoeae Harr. 9(1)
Horama texana Grt. 7(5) 8(95) 9(2438) 10(12) 11(136)
Ctenucha venosa Wlk. 3(2)
Halisidota annulosa Wlk. 12(5)
Apantesis arge Dru. 4(1) 5(5) 1(1)
Ecpantheria sufflusa Schs. 8(17) 9(41) 2(2)
Utetheisa ornatrix L. 6(2) 7(3) 8(13)
Copidryas gloveri G. & R. 9(16) 10(1)
Misa cosyra Dru. 8(4) 9(18)
Alicla infecta Ochs. 7(32) 9(27) 1(6)
Elaphria chalcedonia Hbn. 11(56)
Prodenia sunia Gn. 8(28) 9(182) 1(86) 2(6)
Laphygma exigua Hbn. 11(3) 1(16)
Stiria rugifrons Grt. 9(49)
Basilodes pepita Gn. 9(1)
Heliothis virescens F. 5(2) 6(1) 8(3) 12(1) 2(2)
Schinia regia Stkr. 9(1796) 10(8)
Diastema tigris Gn. 7(23) 8(8) 9(265) 10(8)
Amyna octo Gn. 7(294) 9(1248) 1(11)
Autographa egena Gn. 10(15) 12(2)
Argyrogramma verruca F. 12(26)
Pseudoplusia oo Cram. 11(4) 12(7)
Rachiplusia ou Gn. 8(53) 12(21) 1(106)
Mocis repanda Gn. 9(298) 10(617) 11(926) 12(320) 1(65) 2(1093)
Ptichodis vinculum Gn. 9(10)
Zale lunata Dru. 9(1) 10(1) 11(5) 12(7) 1(6)
Eubolina impartialis Harv. 6(129) 7(124)
Yrias repentis Grt. 8(686) 9(3146)
Erebus odora L. 6(1) 8(2) 9(2) 10(3) 11(2) 12(1)
Melipotis fasciolaris Hbn. 5(12) 10(18) 1(1)
Melipotis agrotoides Wlk. 6(30) 8(5) 10(1)
Panula inconstans Gn. 5(20) 6(12) 7(10) 9(40) 10(30) 11(24) 1(21)
Synedoida inepta Hy. Edw. 8(1)
Palindia dominicata Gn. 12(1)
Anticarsia gemmatilis Hbn. 9(38) 2(2)
Litroprosopus futilis G. & R. 1(1)
Noropsis hieroglyphica Cram. 7(1) 8(1) 9(1) 10(1) 11(2)
Gonodonta pyrgo Cram. 7(10) 9(2) 10(1)
Gonodonta bidens Hbn. 1(1)
Alabama argillacea Hbn. 6(2) 7(452) 8(25992) 9(24265) 10(1980) 11(145) 12(68)
Didugua Argentilinae Dru. 3(3) 4(2) 10(2) 12(4) 1(7)
Artace cribraria Lju. 9(5) 1(1)
Semiothisa punctolineata Pack. 9(9)
Stenaspilates meskaria Pack. 3(5) 11(8) 1(2)

Sphacelodes vulneraria Hbn. 8(2) 9(48)
Hymenia fascialis Cram. 6(21) 8(32)
Desmia funeralis Hbn. 7(52) 8(8) 9(232)
Asciodes anormalis Gn. 11(1) 1(1)
Sylepta silicalis Gn. 6(12) 7(2)
Sylepta obscuralis Led. 6(5) 7(20)
Paradosis flegia Cram. 4(1) 6(1) 7(10) 8(7) 9(13) 11(1) 1(2)
Diaphania nitidalis Stoll. 8(36)
Diaphania hyalinata L. 8(1) 9(2)
Pachyzancla bipunctalis F. 3(10)
Loxostege similalis Gn. 7(25600) 8(12102) 9(18443) 12(2) 1(20) 2(1740)
Pyrausta gracilalis Hlst. 8(238) 9(5588) 1(32) 2(177)
Elasmopalpus lignosellus Zell. 2(1988)
Amorbia emigratella Busck 11(30)
Pectnophora gossypiella Saun. 6(32) 7(5627) 8(32057) 9(8162) 10(0)
Scythris trivinctella Zell. 7(50) 8(134)

THE MACROPTEROUS FORM OF *LAMPRACANTHIA CRASSICORNIS* (UHLER) (Hemiptera: Saldidae)

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The genus *Lampracanthia* Reuter contains the single species *crassicornis* (Uhler). This species has heretofore been known only in the brachypterous condition. The inability to utilize characters of the wing membrane together with the possibility of changes in shape of pronotum, scutellum and hemelytra associated with brachyptery has made the systematic status of *Lampracanthia* less than satisfactory. On June 11, 1950, the author was fortunate enough to obtain a long series of this interesting species at Valentine, Nebraska. Among the specimens was a single fully macropterous female. This specimen differs from brachypterous specimens in the following manner: the posterior portion of the pronotum is relatively longer (ratio of length of anterior to posterior lobe 4.0 in brachypterous material, 2.25 in macropterous); the scutellum is proportionately longer (40:27) with the anterior lobe noticeably more swollen. It is this anterior lobe that accounts for the total increase in size of the scutellum. In the macropterous specimen the ratio of length of the posterior to the anterior lobe is .91 whereas in a rather typical brachypterous individual the ratio is 1.64. The clavus is well differentiated in the macropterous form while becoming fused with the corium posteriorly in the brachypterous condition. The membrane (see figure) contains four cells including the marginal; the inner or mesal cell terminates about one-fifth the distance from the posterior margin of cells two and three.

The genus *Lampracanthia* is closely related to *Chartoscirta* Stal. The macropterous form lends additional evidence to support the relationship. Reuter (1912) uses contiguous ocelli, the location of the pronotal transverse sulcus near the middle of the pronotum rather than near the posterior margin, and position and coloration of the hemelytra to distinguish *Chartoscirta* from *Lampracanthia.* Of these characters the alleged contiguous nature of the ocelli is useless. The ocelli are carried on an elevation in both genera and despite Reuter's statement to the contrary, are not contiguous in either *Chartoscrita*[1] or *Lampracanthia.* The position of the pronotal sulcus still seems to be a valid character despite the fact that the macropterous female studied weakens the distinction. As between the two genera this pronotal character may perhaps be best stated as follows: the anterior lobe is more than twice as long as the posterior lobe in *Lampracanthia* (ratio of 4.0 in brachypterous specimens, 2.25 in macropterous), whereas in *Chartoscirta* the anterior lobe is less than one and one-half times the posterior lobe (ratio of 1.38). The humeral angles are also much more acute in *Lampracanthia* although admittedly less so in the macropterous condition. The dull, non-shining nature of the corium in *Chartoscirta* is in marked contrast to the highly polished pronotum and scutellum, whereas in *Lampracanthia* the hemelytron is as highly polished and shining as the other dorsal areas. The condition of the scutellum appears useful as a generic character. In *Lampracanthia* the anterior lobe is strongly convex and has acute ridged lateral margins, whereas in *Chartoscirta* the lateral margins are bluntly rounded and the anterior portion is less convex, becoming somewhat bilobed by virtue of a mesal depression. The shape of the membrane cells agrees in the two genera. They are four in number and have the mesal cell terminating one-fifth of the distance from the apex of the second cell (see figure).

It appears that while *Lampracanthia* and *Chartoscirta* show rather close relationship, they exhibit sufficient differentiation to conform to most conventional generic concepts within the family.

The habitat of *L. crassicornis* in Nebraska is most interesting. Over 50 specimens were taken in a marshy area adjacent to the Niobrara River. The insects were first discovered on muddy ground in company with *Ochterus americanus* Uhler. However, the majority of specimens were taken on matted marsh grass and sedge growing in water that was from ankle to knee deep. By pressing the vegetation under the water the insects ran rapidly up the stems to escape submersion and were easily collected.

The nymphs of *crassicornis* bear considerable resemblance to those of *Saldoida* and appear to live in somewhat similar habitats. A superficial survey of saldid nymphs available to me seems to indicate that useful information on phylogenetic relationships might be obtained from a serious study of these stages. Certainly nymphs of *Saldula pallipes* (F.) are of a distinctly different type than are those of *Lampracanthia* and *Saldoida.* To accord subfamily status to the latter, primarily on the basis of the peculiar tuberculate condition

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[1] The discussion of the genus *Chartoscirta* is based upon the type species, *C. elegantula* (Fallen).

of the pronotum, and to lump all the other divergent forms of shore bugs into a second subfamily, seems to me to be a most questionable procedure.

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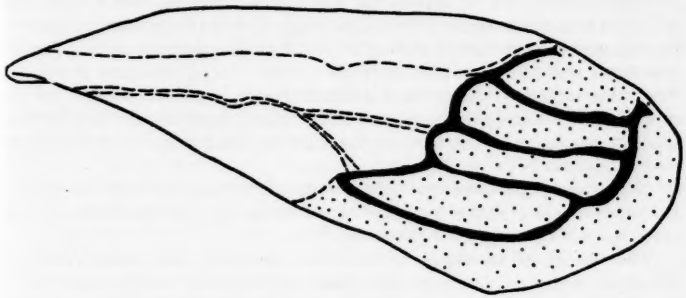

FIGURE: *Lampracanthia crassicornis* (Uhler). Right hemelytron of macropterous female.

INSECTICIDE TESTS AGAINST THE SOUTHWESTERN CORN BORER[1] (LEPIDOPTERA: PYRALIDAE)

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The objectives of this investigation were first to provide a method of controlling the southwestern corn borer (*Diatraea grandiosella* Dyar) in breeding lines, where cost is not of primary importance, and ultimately in commercial field corn. The results so far obtained are encouraging and, in view of the wide interest in this pest, it seems appropriate to make them known at this time.

More than two decades ago Davis and his co-workers (1) found the southwestern corn borer causing some damage to corn yearly and serious damage intermittently in the area it then occupied, a rather vast region centering around southeastern New Mexico and the Panhandle and Trans-Pecos region of Texas. During the years that followed, the borer advanced steadily eastward across Oklahoma (2), thrust a salient into Kansas (4), and recently has spread into western Arkansas. Apparently, the borer has become endemic throughout most of its new range and causes more or less severe damage each year.

[1] Research paper 1156, Journal Series, University of Arkansas. Published with the permission of the Director of the Arkansas Agricultural Experiment Station.

In western Arkansas the southwestern corn borer is the primary pest of field corn. Young plants are commonly killed or dwarfed and heavy tunneling, sometimes accompanied by stalk rot, reduces the vigor of surviving plants. Finally, appreciable loss of grain is caused by girdling activity prior to harvest. Damage, or fear of damage, has been sufficiently great to force many farmers out of corn production.

Previous attempts to control the borer with chemicals met only limited success. Davis tried single applications of nicotine, lead arsenate and various fluosilicates about the time hatching began. With the exception of 80% barium fluosilicate dust, little control was evident even though the borer population was rather light (1). Walton and Bieberdorf were unable to obtain adequate control with cryolite, parathion, toxaphene, chlordane, BHC, or DDT by making two applications, the first shortly after hatching began and the second two weeks later (2).

Since these papers were published, a considerable array of new insecticides have been made available but their usefulness against the southwestern corn borer has not been reported previously.[2]

Procedures. All insecticide tests were conducted at Van Buren, Arkansas, on whorl stage corn planted at such times as to be subject to attack only by the brood of larvae being treated. The percentages of infested plants, including tillers except in the fourth test, were used as a criterion of the effectiveness of the treatment. Each treatment was replicated four times. Data are based on a fifty plant sample from each replication except for an occasional replicate containing less than fifty plants. In such cases all available plants were used.

Sprays were applied with a compressed air sprayer, taking particular care to cover each plant thoroughly and using sufficient spray to obtain run-off irrespective of the gallonage per acre. Dusts were applied with a rotary hand duster, the amounts used being estimated from preliminary trials. Granules were allocated to each replicate by weight and broadcast over the row by hand.

First Test: In the initial test, seven insecticides were used as sprays at the highest dosage it was thought the corn could stand without serious damage, four pounds of active material per hundred gallons of spray. The first application was made when hatching began and the three succeeding applications were made on the 6th, 11th and 16th day following the start of hatching, i.e., at five day intervals. Hatching continued for four or five days after the last application was made. Egg counts taken every fifth day indicated that approximately 1044 eggs were deposited per hundred plants.

The results, given in Table 1, show that only EPN gave sufficient control to warrant further testing.

Second test: Ten insecticides were used in the second test, including EPN at various dosages and in different formulations. Again four applications were made at five day intervals, the first when hatching began. Oviposition was heavy, the several counts totaling 1168 eggs per hundred plants. Hatching continued for three or four days after the last application was made.

In this test endrin, isodrin and heptachlor gave good control at two pounds per hundred gallons and EPN at two pounds and one pound but not at one-

[2] After this was written, a paper by K. D. Arbuthnot and R. R. Walton appeared in the Jour. Econ. Ent. 47(4):707.

half pound. The high percentage of infected plants in the EPN granule treatment was largely due to infestations in the tillers which are difficult to treat with granular material. EPN dust was not effective.

Third test: Endrin, isodrin and heptachlor were used in the third test at one pound and one-half pound dosages and EPN at one pound. These seven treatments were applied four times at five or six day intervals, beginning with hatching. In one treatment only three applications of EPN were made, the first application the day hatching began and the others on the 9th and 17th days, i.e., at eight intervals. In another treatment only two applications of EPN were made, the first on the 9th day after hatching began and the second and last on the 17th day. This treatment also received one application of two pounds of toxaphene per hundred gallons spray, about the time borers began hatching, for control of the numerous fall armyworm larvae present. The check was treated twice with toxaphene. Approximately 1556 eggs were deposited per hundred plants during the entire oviposition period, which extended three days beyond the date the last spray was applied. Some hatching occurred for seven or eight days after the last application was made.

All nine treatments gave adequate control as shown by the data in Table 3.

Fourth test: In this all spray treatments received two applications, the first on the 9th day after hatching began and the second application on the 18th day. Two granule formulations of 5% EPN in 15-30 mesh and 60-90 mesh. Attaclay ("AA" grade, RVM) were included. In one set of treatments each granule formulation was applied on the day hatching began and again on the 9th day. In the second set of granule treatments applications were made on the 9th and 18th days after hatching began. Relatively few eggs were deposited on the test plots, records indicating about 306 eggs per hundred plants, with some hatching a few days after the final applications were made.

From the data, presented in Table 4, it appears that sprays of isodrin at ½ pound and endrin at ½ pound and ¼ pound afforded control equal to that given by EPN at one pound. Granule size did not influence control when applications were made on the 9th and 18th days. When applications were made on the 1st and 9th days, the difference in favor of the smaller size approaches statistical significance. The smaller granules, 60-90 mesh, applied on the 1st and 9th days gave results superior to those obtained with the same material applied on the 9th and 18th days. With the larger, 15-30 mesh, granules the difference between the two treatments approaches statistical significance, the 1st and 9th day applications having the smaller mean percent of infested plants. The best granular treatments compared favorably with the best spray treatments but were more extravagant of active material. However, the minimum, effective dosage of granules has not been determined.

Summary. Adequate control of the southwestern corn borer was obtained in whorl stage corn with EPN at one pound per hundred gallons of spray, isodrin at one-half pound, and endrin at one-quarter pound. It was necessary to use a sufficient volume that the spray ran into the base of the whorls where the young larvae feed for the first nine days or so after hatching. Two applications were effective when applied on the 9th and 17th days after hatching began. This method of control is practical on young corn and particularly on late plantings where loss by "dead heart" and dwarfing is commonly high. On

older and larger corn there are two serious objections to its use: the high volume of spray required and the need for specialized machinery to apply the spray.

Two spray applications of heptachlor at one-quarter pound reduced the percentage of infested plants substantially and four applications at one-half pound gave good control.

Twelve other insecticides, tested as dusts or sprays, failed to give good control. These were: aldrin, BHC (gamma), chlordane, cryolite, DDT, dieldrin, dilan, malathion, methoxychlor, parathion, rotenone and toxaphene.

Granular formulations of the type developed by Whitehead (3) show promise of giving practical control.

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TABLE 1. Effect of Seven Insecticides on Percent of Infested plants, Four Applications at Five Day Intervals, Four Pounds Active Material per Hundred Gallons Spray

Material	Mean percent infested plants	Material	Mean percent infested plants
EPN, e.c.	7.8	Dilan w.p.	63.8
Dieldrin e.c.	41.8	Chlordane w.p.	91.8
Toxaphene e.c.	48.8	Malathion w.p.	92.5
Gamma BHC w.p.	53.8	Check	100.0
		lsd at 5%	20.9

TABLE 2. Effect of Ten Insecticides on Percent of Infested Plants, Four Applications at Five Day Intervals

Material and rate of application	Mean percent infested plants
Endrin e.c., 2 lbs./100 gals.	0.5
Isodrin e.c., 2 lbs./100 gals.	2.0
Heptachlor e.c., 2lbs./100 gals.	2.5
EPN e.c., 2 lbs./100 gals.	3.0
EPN e.c., 1 lb./100 gals.	7.0
EPN e.c. ½lb./100 gals.	35.5
EPN 5% granules. 40 lbs./a.	32.2
EPN 2% dust, 35-50 lbs./a.	60.5
Parathion w.p., 2 lbs./100 gals.	22.5
Aldrin w.p., 2 lbs./100 gals.	41.5
Methoxychlor w.p., 2 lbs./100 gals.	49.5
DDT e.c., 2 lbs./100 gals.	67.0
Cryolite 90% dust, 35-50 lbs./a.	97.2
Check	86.5
lsd at 5%	21.3

TABLE 3. Effect of Various Timing, Dosages, and Insecticides on Percent of Infested Plants

Material and rate of applications	Days from hatching applications made	Mean percent infested plants
Endrin e.c., 1 lb.[1]	1st 7th 12th 17th	1.0
Endrin e.c., ½ lb.	"	2.0
Isodrin e.c., 1 lb.	"	1.0
Isodrin e.c., ½ lb.	"	4.0
Heptachlor e.c., 1 lb.	"	7.0
Heptachlor e.c., ½ lb.	"	6.0
EPN e.c., 1 lb.	"	3.5
EPN e.c., 1 lb.	1st 9th 17th	11.0
EPN e.c., 1 lb.[2]	9th 17th	9.5
Check[3]	-	96.0
	lsd at 5%—	6.0

[1] Pounds active material per hundred gallons spray.
[2] Plus one application of 2 lbs. toxaphene per hundred gallons.
[3] Two applications of 2 lbs. toxaphene per hundred gallons.

TABLE 4. Effect of Various Materials, Dosages, Formulations and Timing on Percent of Infested Plants

Material and rate of application	Days from hatching applications made	Mean percent of infested plants
EPN, 60-90 granules, 40 lbs./a	1st and 9th	0.5
EPN, 15-30 granules, 40 lbs./a.	"	10.0
EPN, 60-90 granules, 40 lbs./a.	9th and 17th	22.5
EPN, 15-30 granules, 40 lbs./a.	"	19.0
EPN e.c., 1 lb.[1]	"	10.0
Isodrin 5% granules 40 lbs./a.	"	13.5
Isodrin e.c. ½ lb.	"	10.0
Isodrin e.c. ¼ lb.	"	21.0
Isodrin e.c. ⅛ lb.	"	35.0
Endrin e.c. ½ lb.	"	16.5
Endrin e.c. ¼ lb.	"	16.5
Endrin e,c, ⅛ lb.	"	21.5
Heptachlor e.c. ½ lb.	"	25.5
Heptochlor e.c. ¼ lb.	"	24.5
Heptachlor e.c. ⅛ lb.	"	36.5
Check	-	79.0
	lsd at 5%—	9.0
	lsd at 1%—	13.2

[1] Active material per hundred gallons of spray.

OBSERVATIONS ON THE LIFE HISTORY OF A RABBIT TICK (*Otobius lagophilus*)

CLUFF E. HOPLA[1]

Information concerning the life cycle of *Otobius lagophilus* Cooley and Kohls,[2] 1940, is meager and it is believed that the following observations are of interest.

On September 4, 1948, 17 black-tailed jack rabbits *(Lepus californicus)* were collected in Cedar Valley, near Fairfield, Utah County, Utah. The greater proportion of this valley appears to be covered with sagebrush and Russian thistle, the soil is of a gray type often found in the arid and semi-arid regions of the west and the average annual rainfall is approximately 12 inches (Alter, 1941).

In checking these animals for the ectoparasites, one was found infested with 6 engorged nymphs of *O. lagophilus*. Five of these nymphs were attached to the throat; one to the upper angle of the lower jaw. The ticks were placed in glass tubes (Hopla, 1953) and stored in appropriate containers over a saturated solution of ammonium chloride.

Sixteen days after the ticks were removed from the rabbit, one specimen moulted to the adult stage; the remaining five specimens required 20 days. The adults consisted of 4 females and 2 males. From the time the nymphs

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[2] Appreciation is expressed to Mr. Glen C. Kohls, Rocky Mountain Laboratory, Hamilton, for verifying the identification of this species.

were collected, only slight activity was observed and this same condition characterized the adult stage. On November 10, approximately 47 days after emerging as adults, one pair of ticks was observed copulating. Whether this was the first, or only, time that copulation took place is not known.

Oviposition commenced February 16, 1949, sixty seven days after copulation was observed. The remaining females began oviposition within 48 hours after the first observation. Oviposition of the first egg mass was completed in 10 days. The females remained directly over the eggs, giving the appearance of brooding them. The average number of eggs per female was 175 with a minimum and maximum of 100 and 250.

Oviposition was of the intermittent of interrupted type similar to that discussed by Hooker, Bishopp, and Wood (1912) for *Otobius megini* (Dugès, 1884). All females survived to deposit at least three different egg masses. One female started laying eggs for the fourth time on June 23, 1949, and completed this process 7 days later. As indicated in the above information, the longest period of time for oviposition to be completed was 134 days. Generally, by the time the larvae from one egg mass were emerging, the females were repeating the egg laying process. This prolonged oviposition without obtaining food in the adult stage is most interesting, and deviates from the general pattern exhibited by the majority of soft ticks. The number of eggs deposited in the subsequent batches corresponded in general with the number reported for the first.

Larval emergence from the first egg mass began March 6, 1949, approximately 11 days after oviposition was completed. Ten days later the remaining viable eggs had hatched. The larvae that emerged from subsequent egg masses required approximately the same length of time for this particular phase of the life cycle. The larvae were more active than either the nymphs or the adults. They seemed sensitive on exposure to high humidities, apparently similar to *O. megnini* in this respect (Hunter *et al*, 1912). Fasting larvae were found to survive from 29 to 65 days when stored in jars over a saturated solution of ammonium chloride at room temperature.

Attempts to feed the larvae on various hosts were not successful. Attachment did occur on a guinea pig; unfortunately this host animal died before engorgement was completed. Subsequent efforts on rabbits, white mice and a human volunteer proved unsuccessful, even for attachment. As to the cause for this failure, no reason is known. Unfortunately, the pressure of other studies made it impossible to pursue these observations further.

Edmunds (1952) did not collect this species in the course of his studies in Utah. Insofar as is known, this is the first record for *O. lagophilus* for this state. However, Cooley and Kohls (1953) report records from surrounding states. Since the date of the original collection, several attempts have been made to secure additional specimens from this area but they proved unsuccessful.

SUMMARY

Observations regarding certain phases of the life cycle of *Otobius lagophilus* are reported. Oviposition was of the interrupted type and requires several months to complete.

The collection of this species in Utah constitutes a new state record.

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NEW SPECIES IN THE GENUS *PARATARACTICUS* COLE FROM SOUTHERN CALIFORNIA (DIPTERA: ASILIDAE)

CHAS. H. MARTIN
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The genus *Parataracticus* which Cole (1924)[1] erected on the basis of a single species, *rubidus* Cole, belongs to that group of asilid genera which possess a terminal, curved, ventral spine on the fore tibiae. Examination of a number of undescribed species at hand indicate that several characters which Cole listed as generic are actually only specific, such as length of antennae, number scutellar bristles, and the pollinose pattern on the polished disc of the scutellum. The genus possesses small, poorly developed pulvilli which Cole believed were lacking and these are specific as to size. Cole's belief that the emargination of the antennae related *Parataracticus* to *Taracticus* might be questioned because *P. niger* lacks the emargination. Cole described the abdomen of *Parataracticus* as finely punctate but the specimens of the several species at hand have abdomens which are more prominently rugose than puntate. The abdomen of *Taracticus* at hand is smooth and punctate. Fairly strong bristles and a clothing of relatively long, depressed hair on the tibiae suggest a relationship to *Ablautus;* the bristles of the mystax and of the thorax are similar to those of *Lestomyia.* The more robust abdomen readily separates *Parataracticus* from *Lestomyia* and *Ablautus* which have more slender abdomens. All three genera are found resting on the ground in arid areas.

Parataracticus wyliei n. sp.

MALE. Length 6 mm., average size larger than *P. rubidus,* reddish species with silvery and golden brown pollinose markings; third antennal segment twice as long as that of *rubidus;* disc of scutellum with wide marginal, semicircular pollinose band surrounding a bare, glossy red spot which touches the mesonotum.

[1] Cole, F. R. 1924. Notes on the Dipterous Family Asilidae, with descriptions of new species. The Pan-Pacific Entomologist I (1): 7-13.

Face light brassy white pollinose, lighter parafrontals, vertex and ocellar tubercle somewhat darker than rest of face. Posteriorly vertex and ocellar tubercle golden brown, upper occiput darker than vertex, lower occiput and narrow band along eyes on upper occiput grayish white. Mystax sordid white, extending halfway to antennae; bristles of antennae, ocellar tubercle, upper fourth of occiput light brown, marginal bristles on lower three-fourths of occiput pale. Two ocellar bristles. Palpi and proboscis reddish with pale hair. Antennae yellowish brown from ventral side and appearing darker on other surfaces, narrow dark brown ring on second segment; first segment about as long as second; third segment about 8 times longer than first and second segments together, apical three-eighths narrowed, microscopic style with small bristle on dorsal side of antenna at about one-fourth distance from apex. Long light reddish bristle and two shorter ones on first antennal segment; short, pale hair around distal margin of second.

Thorax: Silvery pollinose except reddish nude area just above scutellum is surrounded by a pollinosity brownish in some lights and silvery in others; broad median stripe ending between bases of posterior acrosticals, broad, golden brown pollinose geminate spots on either side of stripe, light golden brown mark above, on and below humeri; thoracic bristles straw colored. Upper part of mesopleura mostly silvery, margined by golden brown pollinosity, polished red below, metapleura mostly polished. Scutellum with 6 yellowish bristles. Fan 12-15 white hairs before white halteres (about same number for *niger* and about half as many and shorter for *rubida*). Fore coxae silvery pollinose anteriorly, polished red posteriorly; middle coxae polished; hind coxae silvery pollinose laterally and anteriorly, with anteriorly projecting spine (this spine smaller in *rubida* and not present in *niger*).

Abdomen: Red, shining, punctuate, covered with sparse, short pale hair; first segment with brownish silver spot anterior and below the three pale bristles on posterior corner; lateral margin segments 2-5-6 more broadly pollinose than 3-4, golden brown pollinosity along margin very thin and seen only in certain lights, small silver spot on anterior corners segments 2-3-4, broadly interrupted silvery band originating on the posterior corners of segments 2-3 and extending mesaly at about a 20-degree angle, band on segment 4 parallel to posterior margin, segment 5 with band on lateral margin broader than on 3-4, segment 6 with wide anterior pollinose band interrupted more or less medially. Venter, mixture of silvery and golden brown pollinosity.

Legs: Reddish, bristles on femora and tibia white, tarsal bristles and spines on hind legs black (pale white in *rubidus*), dorsal bristles and small spines on anterior tarsi white, ventrally black, claws black.

Wings: Hyaline with sparse microchaetae; one-third longer than wide; furcation of third vein distinctly beyond base of the second posterior cell (furcation is opposite or before in *rubida*), discal crossvein slightly beyond center of discal cell.

Female. 7 mm. Similar to male except third segment of antenna is spatulate, about 3.3 times longer than length of first and second segment together, and twice as wide at tip as at base, style not differentiated, microscopic spine near tip; markings on abdomen similar to male except confined to lateral

margins of segments 6-8. Tarsal bristles on hind leg all black, mostly black on middle leg, and all white on fore leg.

Holotype: Male, Wrightwood (2 miles north), Southern California, July 27, 1952. Chas. H. Martin, coll.

Allotype: Female, same locality and date. Dorothy Wylie Martin, coll. Paratypes: Six specimens same data as holotype (J. Wilcox, Chas. H. Martin); four males, two females, Monrovia Canyon, Calif. Aug. 2-24, 1931 (Chas. H. Martin); 2 males, Tanbark Flat, Los Angeles Co., Calif.. July 12, 1950 (R. Schuster); July 12 ,952 (J. H. Nakatta); two males on one pin, one female, Crystal Lake Road, 4700 ft. alt., Los Angeles Co., Calif., July 9, 1952 (J. H. Nakatta, A. A. Grigarick); male and female in copula, Buckhorn Flats, Los Angeles Co., Calif., July 20, 1941 (J. Wilcox); two males, Camp Baldy, San Bernardino Co., Calif., July 7, 1952 (R. M. Bohart); two males, Santa Ana Canyon, Peralta, Orange Co., Calif., July 25, 1953, one female, August 25, 1954 (Chas. H. Martin).

While Wrightwood, altitude 6200 feet, has been designated as the type locality because this is a wilderness area and not likely to be encroached upon by civilization, yet this species has been collected in Santa Ana Canyon at about 500 feet altitude within 17 miles of the coast.

This species is named after my wife Dorothy Wylie Martin who has collected many good species of Asilidae.

Parataracticus niger n. sp.

MALE. Length 5.3 mm. Approximately same size as *P. rubidus* Cole; separated from other known species by black abdomen with silvery markings.

Head: Face below antennae, parafrontals, occiput, silvery white pollinose; front, occelar tubercle, brown with white pollinose overcaste, vertex except parafrontals white pollinose and ocellar tubercle, reddish brown; an irregular round polished black spot just above antennae extending as a narrow line between antennae; occiput white pollinose except brownish at base ocellar tubercle. Bristles around oral margin, antennal, parafrontal, and occipital bristles either white or pale to reddish brown, five ocellar bristles dark brown; white mystax bristles extend almost to base of antennae, hair on head white. First antennal segment slightly longer than second, both reddish brown, thinly white pollinose, single long strong pale bristle anteriorly on first segment, third segment black, approximately 4.4 times longer than one and two combined, apical fifth bent and narrowed, near apex an emargination containing microscopic style with a small pale spine.

Thorax: Silvery pollinose, with brown pollinose geminate stripe terminating at fifth pair of acrosticals, separated anteriorly by a silvery pollinose stripe, brown spot on humerus, three on each side of geminate stripe, grayish spot (almost black in some lights) between the posterior acrosticals and extending to scutellum, polished black on postalar callus; thoracic bristles pale reddish brown, short white hair around acrosticals on pronotum and long white hair on collar. Pro and metapleural regions mostly white pollinose which extends beneath the polished black underside of scutellum, mesopleural region with broad, black, polished band partially interrupted by silvery pollinose stripe, extending from wing base to middle coxa. Five pale

reddish brown bristles on polished black margin of scutellum; disc of scutellum silvery pollinose.

Abdomen: Black to dark red; covered with sparse pale hair shorter on anterior four segments and longer on posterior; 3 to 6 white bristles on posterior corners of first three segments, one short bristle on segment 4, hair on genitalia white; segment 1 with white pollinose spot around base of bristles on posterior corners; segment 2-5 black anteriorly and variable amounts of dark red posteriorly, 6-7 mostly dark red; interrupted white pollinose stripes near posterior margins segments 2-4 joining lateral white pollinose wedges, wedge along entire margin of segment 2 and only on posterior corners of segments 3-4, entire on margin of segments 5-6. Venter white pollinose except medially on segments 3 to 6.

Legs: Dark reddish, black dorsal stripe on femur, tibia with ventral black stripe, pale hair and bristles except ventral black apical bristles, spines of hind tarsi black, middle and fore tarsi dorsal spines white, lateral and ventral spines black.

Wings: Hyaline, with sparse microchaetae, discal crossvein beyond center of discal cell, furcation of third vein beyond base of second posterior cell, all cells open.

FEMALE. 7 mm. Similar to male except third segment of antennae 2.6 times longer than one and two together and approximately one-third wider near apex than at base, on outside of apex a narrow short style tipped with a very short dark bristles; fifth abdominal segment with broadly interrupted posterior stripe, segment 7 with a small white spot on lateral posterior margin, segment 8 totally polished black.

REMARKS. The proportion of the antenna bent near apex varies from 15 to 50 per cent of the total length; in some paratypes antenna is not bent. Vertex of some specimens is totally white pollinose and not brown as in holotype specimen. Greased specimens show the area beneath the pollinose markings to be red in color.

This species, as with others in the genus, is found on the ground in dry areas where vegetation is usually rather sparse. Usually collecting was tedious but on one occasion a satisfactory series was taken along a very shallow wash about 3 to 6 feet wide in a half hour. A few specimens of *Nannocyrtopogon* n. sp. were taken at the same time.

Holotype: Male, Perris, California, May 9, 1953, Chas. H. Martin, coll. Specimen taken about 7 miles northwest of Perris on road to Corona.

Allotype: Female, same data.

Paratypes: Forty eight specimens, same locality and date, one female collected May 30, 1953 (J. Wilcox and Chas. H. Martin); three males, 1½ miles west Perris, California, May 4, 1938, May 13, 1937, June 2, 1938; one male, Riverside, Calif., May 6, 1931, (P. H. Timberlake); four specimens, Aguana, Calif., May 11, 1953 (Chas. H. Martin); one male, Temecula, Riverside Co., Calif., May 24, 1951 (E. I. Schlinger); one female, Riverside, Calif., June 1, 1954, (J. Hall).

Types of both species in the writer's collection.

Parataracticus rubidus Cole

A series of 31 specimens of this species collected by P. H. Arnaud, Jr. at Stanford University on May 27, 1949, was loaned to the writer by J. Wilcox. Cole recorded a paratype specimen from the same locality. The style of the female of both *Parataracticus rubidus* and *wyliei* is located slightly below the apex of the third segment, whereas the style of the female of *P. niger* is on the apex. Superficially *rubidus* resembles *wyliei* and several other undescribed species from central California near the Bay area.

A BRIEF NOTE ON THE SLEEP OF MALE *MELISSODES* (HYMENOPTERA: APIDAE)[1]

JOHN A. MATHEWSON[2] and HOWELL V. DALY

At 8:15 on the morning of July 8, 1953 numerous groups of torpid bees were noticed on floral spikes of *Verbena stricta* at a weedy clearing 8 miles southeast of Lawrence, Kansas. Except for two isolated males of *Melissodes vernoniae* Robertson, never seen again, all proved to be males of *M. perplexa* Cresson. The bees occurred singly and in clusters of up to six. They clung closely to the spikes in horizontal and face-downward positions and, when handled, lay torpid for several seconds before attempting to escape. The greatest number of aggregations occurred on one particular small clump of spikes, although scattered sleepers were found on plants up to 20 feet away. Individuals of this focal clump were marked. The groups dispersed within an half-hour.

Males returned and settled for sleep on the same plants between 5 and 6 p.m. that day. The above-mentioned focal clump again supported the largest population of sleepers. Many marked bees were recovered on this clump; they were never at any time found elsewhere.

Essentially identical observations, including the recovery of marked individuals, were made on the morning and evening of the following day. No sleepers were seen thereafter.

These observations agree closely with those described for *M. obliqua* by the Raus (1916) and lend support to the idea that males of these species not only return to a given sleeping area, but are able to recognize and return to a definite plant for rest.

The authors are grateful to W. E. LaBerge (Department of Entomology, University of Kansas) for determination of the bees.

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